FALL 1979
AUTOMNE 1979

Reliance on fossil fuels will continue but attention is being paid to renewable energy resources. See story on pages 3 and 7.

On continue à dépendre des carburants fossiles mais on étudie présentement d'autres sources d'énergie renouvelable. Voir à la page 5 et 7.

CANADA AGRICULTURE

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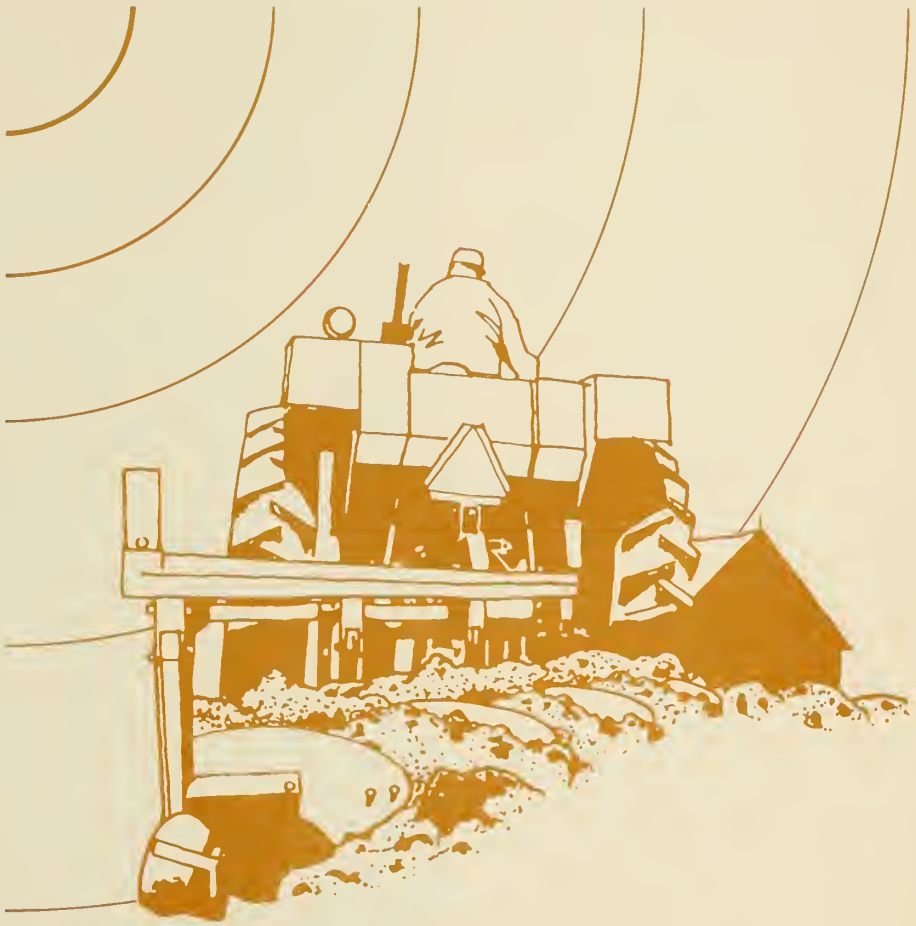
ENERGY IN AGRICULTURE

D. J. SMITHERS



Energy is as essential to modern Canadian agriculture as soil and water.

Without large energy inputs — usually in the form of fossil fuels — productivity would plummet. And the result would be food shortages and higher prices.

But, as in all Canadian industries, efforts are intensifying to find ways of using less energy to get the job done — in agriculture, producing food. At the same time the search is on for practical uses of alternate, renewable sources of energy.

The biggest energy input in agriculture is gasoline and diesel fuel for farm machinery and natural gas for the manufacture of fertilizers.

And the realities of production demands and farm labor supplies will boost rather than decrease the emphasis on farm mechanization and its reliance on fossil fuels.

At Agriculture Canada, engineers are leading research to reduce fuel demands and at the same time identify agricultural operations that could make use of alternate energy sources.

Already, zero tillage is being practised on the Canadian prairies, reducing field work before seeding. Other studies have centered on matching horsepower requirements to farm implements. The economy of diesel engines already has resulted in increased sales of tractors so equipped.

While Agriculture Canada economists say reliance on fossil fuels will continue for the foreseeable future, much attention is being paid to renewable energy sources — solar and wind power and energy production from biomass methods — and their possible place in Canadian agricultural operations.

Some energy-hungry chores, such as space heating animal shelters, drying grain on the prairies, pumping water for livestock and limited electricity generation, can already make some use of renewable energy sources.

Solar space heating for swine and poultry houses holds promise. Low-temperature grain drying is under careful study with some pilot units already in operation and showing a potential savings of 50 per cent of consumption of conventional fuels.

Energy conservation and solar heating in greenhouses both show promise of fuel savings. Work in these areas is being expanded in Agriculture Canada according to Harold Jackson and Dr. Jim Monroe, two engineers involved in the department's solar program.

Solar-powered irrigation systems already are being tested in the United States. However, these have not yet been tested in Canada.

"But as far as renewable energy sources are concerned, plants still rate as the largest collectors and converters," says Gordon Timbers, an energy specialist with Agriculture

Canada's Engineering and Statistical Research Institute in Ottawa.

The processing of plant material — a form of biomass — can produce a wide range of chemicals, many of which promise to fit into the energy consumption patterns of agriculture.

Wood-fired electrical generating stations could become a viable energy option to serve some areas of Canada, and already the technology is in place for production of the raw materials needed in such systems.

"In Canada, work is centered on the forest industry, with its very large potential biomass resource," Dr. Timbers says. "Harvesting waste, saw mill wastes, diseased stands (such as budworm infected areas) and high yielding hybrid poplar all figure in the biomass resource."

Other biomass techniques could involve the use of a portion of the estimated 20 million tonnes of straw produced by Canadian agriculture as fuel. Direct combustion or gasification to provide energy for grain drying and space heating are possible uses, and these options are being tested.

Production of methane gas — also used as a fuel — through the fermentation of animal wastes is another energy option from agriculture. Through contracts from Agriculture Canada, scientists at the University of Manitoba have been testing fermentation processes for the past five years and two farm demonstrations are currently ongoing.

"Windmills were very popular in the 1930s," Dr. Timbers says. "From an economic standpoint, they are a speculative alternative at the present time."

Their small output, whether for electrical generation or water pumping, would have little impact on the energy demands of the modern farm.

"Agriculture is in a unique position, with several renewable energy options to possibly exploit for its own use and the use of others," Dr. Timbers says.

Farm machines are becoming larger and larger, as farmers strive to increase production. Rising fuel prices are placing more emphasis on energy-efficient means of cultivation and harvesting.

Dave Smithers is an interpretive writer, Information Services, Agriculture Canada.

L'ÉNERGIE EN AGRICULTURE

D. J. SMITHERS

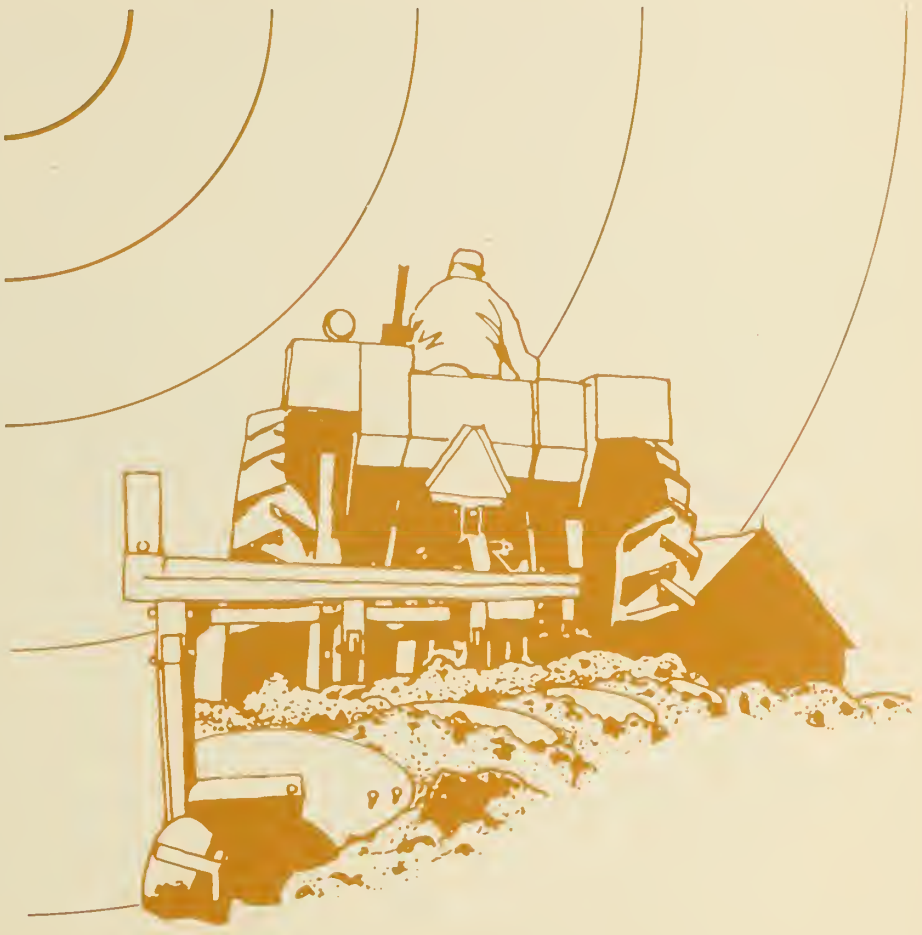
L'énergie est aussi indispensable à l'agriculture canadienne que le sol et l'eau.

Faute d'un apport important d'énergie, qui prend généralement la forme de carburants fossiles, la productivité ralentirait et il s'ensuivrait des pénuries d'aliments et des hausses de prix.

Toutefois, à l'instar de toutes les industries canadiennes, l'agriculture multiplie ses efforts pour découvrir de nouvelles façons d'économiser l'énergie tout en conservant le même rythme dans la production alimentaire. Par ailleurs, les chercheurs se penchent du côté de l'utilisation pratique des sources d'énergie renouvelable.

Les sources d'énergie les plus employées en agriculture sont l'essence et le combustible pour moteur diesel pour la machinerie agricole, et le gaz naturel dans la fabrication des engrais. A cet égard, les besoins de la production et les disponibilités de main-d'œuvre agricole intensifieront davantage le recours à la mécanisation et l'emploi des carburants fossiles.

Les ingénieurs d'Agriculture Canada effectuent actuellement des recherches afin de diminuer la consommation d'essence, et identifier les activités agricoles pouvant mettre à profit l'emploi d'autres sources d'énergie. Déjà, les agriculteurs des Prairies utilisent la méthode du semis direct, ce qui représente une économie de travail avant l'ensemencement. D'autres études ont tenté d'établir le rapport idéal entre les besoins en force motrice et les machines agricoles. Les économies réalisées grâce au moteur diesel commencent à faire accroître les ventes de tracteurs équipés de la sorte.



Pour autant qu'on puisse le prévoir, on continuera d'avoir recours aux carburants fossiles, mais les sources d'énergie renouvelable (la puissance solaire, éolienne et l'utilisation de l'énergie de la biomasse), ainsi que leur potentiel d'utilisation en agriculture font l'objet d'une attention particulière.

En outre, il serait possible de tirer parti des sources d'énergie renouvelable pour certaines opérations à consommation énergétique élevée, tels le chauffage des abris pour animaux, le séchage du grain, le pompage de l'eau destinée au bétail et la production limitée d'électricité.

Le chauffage des porcheries et des poulaillers à l'énergie solaire offre des possibilités intéressantes. Le séchage du grain à basse température fait l'objet d'une étude attentive. Les expériences en cours laissent entrevoir des économies de carburants traditionnels allant jusqu'à 50%. La conservation de l'énergie et l'utilisation de l'énergie solaire dans les serres permettront aussi de réaliser des économies substantielles de carburant. Selon MM. Harold Jackson et Jim Monroe, ingénieurs du programme d'utilisa-

tion de l'énergie solaire au Ministère, les travaux en ce sens vont bon train. Les systèmes d'irrigation mus par l'énergie solaire font déjà l'objet de tests aux Etats-Unis.

Selon M. Gordon Timbers, spécialiste de l'énergie de l'Institut de recherches techniques et statistiques d'Agriculture Canada (Ottawa), les plantes restent les plus grands transformateurs et accumulateurs d'énergie renouvelable. La transformation de matières végétales, une forme de biomasse, peut fournir une grande variété de produits chimiques dont un grand nombre pourraient servir les modes de consommation énergétique de l'agriculture.

Les centrales produisant de l'énergie électrique à partir de la combustion du bois pourraient devenir une option rentable dans certaines régions du Canada.

Les recherches se sont concentrées sur l'industrie forestière. Les rebuts des coupes, des moulins à scie, les régions infestées (par la tordeuse par exemple) et les peupliers à rendement élevé sont des ressources de la biomasse.

Une partie des quelque 20 millions de tonnes de paille produites chaque année par l'agriculture canadienne, pourrait servir, par combustion ou gazéification, de source d'énergie pour le séchage des grains ou le chauffage.

La production de méthane, utilisé également comme carburant, à partir de la fermentation de déchets animaux, représente une autre source énergétique provenant de l'agriculture. Des chercheurs de l'Université du Manitoba analysent les procédés de fermentation depuis cinq ans à la suite de contrats conclus avec Agriculture Canada. Deux fermes modèles mettent actuellement cette technique en valeur.

Les machines agricoles deviennent de plus en plus grosses, à mesure que les agriculteurs cherchent à accroître la production. L'augmentation des prix du carburant nous force cependant à envisager des méthodes de culture et de moisson plus économiques en matière d'énergie

«Les éoliennes, très populaires dans les années 1930, représentent aujourd'hui une solution de rechange possible du point de vue économique, poursuit M. Timbers. Toutefois, leur faible rendement, tant sur le plan de la production d'électricité que du pompage de l'eau, ne saurait répondre entièrement aux besoins énergétiques de la ferme moderne.

«L'agriculture jouit donc d'une position unique, de dire M. Timbers, puisqu'elle dispose de plusieurs sources d'énergie renouvelable qu'elle pourra exploiter pour son propre usage et celui des autres secteurs.»

David Smithers est rédacteur de vulgarisation, Services de l'information, Agriculture Canada.

ENERGY USE IN THE HORTICULTURAL CROP AND FOOD SYSTEM

Writing in the June, 1979 issue of *Canadian Farm Economics*, I. F. Furniss of Agriculture Canada's Policy, Planning and Economics Branch analyzed current energy use in the Canadian horticultural crop and food system and evaluated some of the alternatives.

Total energy consumption in the Canadian economy in 1976 was 6.1 x 10^{15} Btu, of which primary agriculture accounted for less than 3% in direct use. Direct and indirect energy consumption in the entire Canadian food system, however, was estimated at 1.4 x 10^{15} Btu, somewhat less than one-quarter of the total. Agricultural production consumed 18% of the total food system's energy.

Direct fuel costs for field-grown horticultural crops are a relatively small percentage of farm operating expenses, generally less than 5%. In vegetable greenhouse production, however, fuel costs account for almost one-third of operating costs. Hence, the impact of the higher energy prices since 1974 has been much more severe for the greenhouse sector than for the field-crops sector.

Beyond the farm gate much more energy is used in the food system for the processing, transportation, distribution, and home preparation of horticultural food crops. For example, it takes over 7,000 Btu from production to home preparation to put a pound of canned peas on the consumer's table. Only 15% of this, however, is accounted for by production energy; the largest proportion goes in processing, 38% of the total. But, when the energy used is priced, home preparation then accounts for 43% of the total energy cost per pound of peas placed on the table.

Alternatives to the present levels of energy consumption in the horticultural food crop system are limited. Large energy savings can usually be accomplished only with significant capital investments. Even at 1978 energy prices, the savings in energy costs alone may not justify large new capital investments unless the change is also accompanied by other resource savings, such as labor. The greatest potential for reducing energy costs in the horticultural food crop system in the short-run generally lies in the more efficient use of energy by the adoption of known technology for energy conservation.

The potential for developing low-grade or waste heat sources associated with power plants and natural gas transmission line compressors for greenhouse heating is presently under investigation by a number of agencies. The existing greenhouse industry, however, appears more likely to adjust to higher energy prices by retro-fitting to reduce fuel consumption and by switching to higher-value crops. The higher energy prices experienced so far, however, do not appear to have had any greater impact on energy costs for horticultural crops grown under non-irrigated field conditions than on other types of crop farming.

WIND AND SOLAR POWER FOR AGRICULTURE

H. R. DAVIDSON

Suite à la hausse du coût de l'énergie, il importe de trouver des solutions de rechange pour les industries fortement mécanisées.

On a mené, à la station de recherches de Swift Current, Saskatchewan, une série d'expériences qui ont donné des résultats prometteurs. Il s'agit du séchage solaire des grains et de la transformation du vent en énergie. Trois types de chauffages solaires ont été étudiés, tandis qu'un rotor Darrius est également mis à l'essai.

Recent increases in energy costs have placed a financial burden on the prairie agricultural community. In a highly mechanized industry such as agriculture, these increases must ultimately be passed on to the consumer or be absorbed by the producer. Hence, any means which can be found to reduce energy costs would be beneficial.

In these energy-conscious times, interest is turning to alternate energy sources to supplement existing supplies. These so-called "soft technologies" are attractive, because on the surface they promise an inexpensive and seemingly inexhaustible

Figure 1. Solar grain drier at Swift Current. The collectors are attached to the sides of the 4.3-m (14-foot) diameter grain bin. The fan is housed inside a plenum facing south.

energy supply. However, deeper investigation reveals that even renewable energy comes with a price tag. From an agricultural viewpoint the questions which must be answered regarding renewable energy are as follows: Is there an agricultural application? If so, what is the price?

At Swift Current work has begun to answer these questions. Solar grain drying and wind-generated electricity are two alternate energy sources which might be useful to western agriculture.

Western cereal producers can be proud of the fact that they are net energy producers. In fact, at the farm gate about two to three times as much energy is produced in the form of cereals as is consumed in all farm operations. In one sense cereal producers are the solar energy experts because it is through their management of cereal plants that solar energy is used to power the plant photosynthetic process which produces grain.

On the earth's surface solar energy is a low temperature heat source. This characteristic may limit its use in high temperature grain drying but makes it ideal for the low temperature method. With this latter method the tough or damp wheat is stored in bins and large volumes of slightly heated air is forced through the grain. The air cools and dries the grain. The temperature of the air need only be heated 3 to 5°C above the surrounding temperature to reduce the relative humidity to the desired level. A medium-sized simple air solar collector can easily obtain temperature increases of this magnitude with the appropriate air flow rate. Experience indicates that this method works well when the average surrounding temperature is about 4 to 5°C. This is consistent with autumn temperatures in Western Canada, and as an added advantage the relative humidity is also usually low.

The grain drying project at Swift Current is carried out in cooperation with the Family Farm Improvement Branch of the Saskatchewan Department of Agriculture. The design of the three solar collectors that were built is simple. Galvanized metal, painted black on the outward facing side is covered with transparent fiberglass-reinforced plastic. An air space is maintained between the back surface of the metal and the supporting structure. When the sun shines through the transparent plastic it heats the metal. Air is drawn through the air space and absorbs the heat from the back of the metal, thereby lowering the relative humidity. This air is then blown through a false floor on the bottom of the grain bin and forced up through the grain. As it passes it dries the grain by absorbing the moisture from it. It is the lowered relative humidity of the air which increases its ability to absorb moisture.

The three solar units were built during the fall of 1977 and spring of 1978. The intention was to evaluate the practicality, cost, and operational techniques of owner-fabricated solar grain driers. The first

Figure 2. Solar Collectors attached to the roof and southern wall of a wooden grain bin.

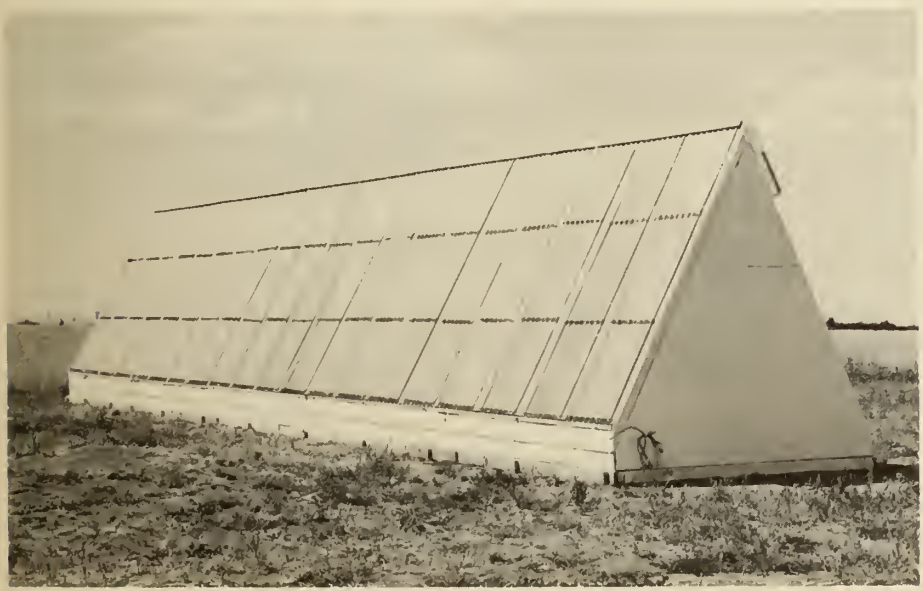


Figure 3. Solar collector (A-frame construction) with crushed gravel heat storage medium inside. Area of collector is 30.5 m²

unit was built onto the side of a circular bin 4.3 m (14 feet) in diameter and covered two-thirds of the circumference centered south. The second unit was built on the south-facing roof and side of a square wooden grain bin. The third was a self-supporting A-frame structure measuring 2.4 x 2.4 x 2.4 m (8 x 8 x 8 feet); this incorporated a short-term rock heat storage medium.

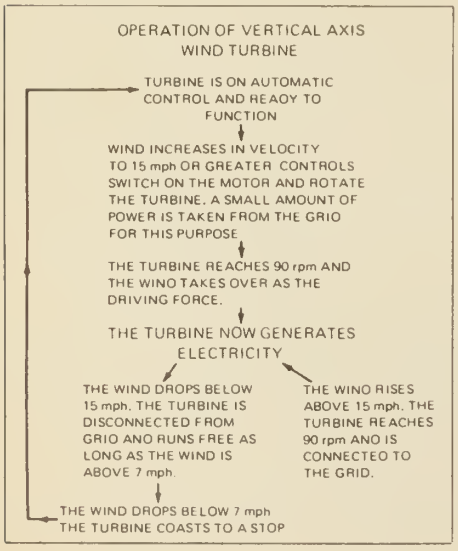
Tests for only the first year have been completed and all of the results have not yet been assessed. However, in the round bin 18 t (800 bushels) of wheat were dried from 19% moisture to 14.5% moisture with no deterioration. And all of the units provided enough temperature rises in the air stream, usually more than required. The first year's results, if not conclusive, are certainly encouraging.

Wind has long been harnessed as an energy source on the Prairies for pumping water or generating electricity. Thirty-two volt DC wind generators with battery storage were popular during the 1930s and 1940s and multibladed wind-mills for pumping water are still a common sight.

The National Research Council (NRC) has recently revived an old design, the Darrius Rotor or Vertical Axis Wind Turbine (VAWT) which has many features superior to the older, horizontal type. It has a short tower, no directional vane, and most important, costs less to build. Furthermore, its unique design allows it to withstand high wind velocities from any direction without being damaged, and it requires little maintenance.

During the summer of 1978 a VAWT was installed at the Swift Current Research Station as a cooperative project between the Research

Figure 4. Work crew constructing the Vertical Axis Wind Turbine, tower, and generator at Swift Current during August 1978.



Station, the Saskatchewan Power Corporation, and the NRC. The unit consists of a vertical axis rotor 17.4 m (58 feet) high and 11.2 m (37 feet) in diameter mounted on a 9.1-m (30-feet) tower. The unit is hooked into the electrical grid system and works in association with the grid. Maximum electrical output is expected to be 56 kW, based on a projected wind speed of 29 km an hour.

The turbine will be assessed over a period of 3 years for practicality and performance under prairie weather conditions. During this time other applications for wind power will be investigated. Smaller units for individual farm use are

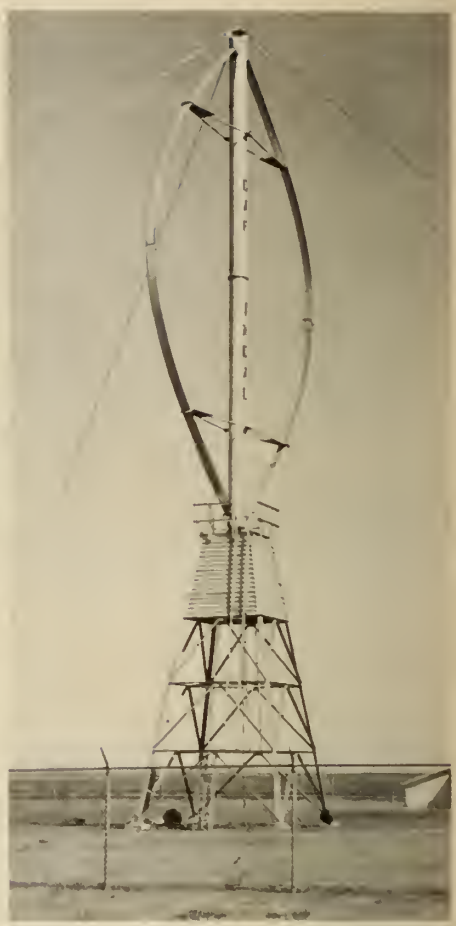


Figure 5 The Vertical Axis Wind Turbine at Agriculture Canada's research station, Swift Current, ready to operate.

being considered as electrical generators, heat producers, and pumps.

Solar and wind energy on the farm are still in the experimental stage. However, experimental results are promising and in the near future both could make a significant contribution to Canadian agriculture.

H. R. Davidson, Ph D. is a researcher in Agrometeorology at Agriculture Canada's research station at Swift Current, Saskatchewan

SELECTING FOR RESISTANCE TO *SCLEROTINIA* IN SUNFLOWER

J. DUECK

Le sclerotinia qui cause la pourriture sclérotique du tournesol est non spécifique, c'est-à-dire qu'il se retrouve sur plus de 300 espèces de plantes, toutes des dicotylédons. Dans les rapports faits sur les espèces susceptibles au sclerotinia, comme par exemple le tournesol, jamais on n'a parlé d'immunité complète. La variance de susceptibilité est démontrée par les différences de degré de flétrissement (tableau 1). La réaction des plantes aux éléments pathogènes dont le degré de spécificité est bas, s'avère très variable et dépendante des conditions environnementales.

In its relatively brief history of commercial production in Canada, sunflower has been affected by a number of plant diseases of major importance including rust, downy mildew, *Verticillium* wilt and *Sclerotinia* wilt. The first three are relatively specific in the host plants they are able to infect, showing specialization even among varieties within a host plant species. Because of their specialization it has been possible to identify genetic resistance to these three diseases and successfully incorporate it into varieties suitable for cultivation. For this reason, diseases which are potentially devastating cause minimal economic damage. However, *Sclerotinia* wilt caused by *Sclerotinia sclerotiorum* is as non-specific in its ability to affect plant species as the others are specific. *S. sclerotiorum* has a host range of more than 300 plant species, all of which are dicotyledonous. Among common crop hosts in addition to sunflower are rapeseed, field pea, white bean, lentil and forage legumes.

Figure 1. Infection progressing from roots upward in the stem.

Sclerotinia occurs widely in soils of Western Canada. Most sunflower fields show some infection and individual fields with more than 90% infected plants have been observed. The pathogen survives in soil as sclerotia, which are storage organs similar to seed of higher plants or as vegetative mycelium in residue of infected plants from the previous season. The duration of survival in soil is not known; however, rotations of 4-5 years between susceptible crop species are insufficient to avoid the disease.

Wilt symptoms result from infection of root tissue by mycelium originating from sclerotia in the soil. Infections progress from the roots up the stem. [Figure 1, 2]. Infected tissues are characterized by a soft, watery rot, tan in color and a tendency to shred as they dry.

Symptoms first appear near the onset of flowering. New infections may continue to appear until harvest time. Plants infected at mid-flowering or later may set seed; however, their yield is reduced and frequently they lodge before healthy plants are mature. Although wilt is the predominant symptom of this disease, occasionally plants are infected in the heads only [Figure 3]. This occurs under conditions which permit sclerotia to germinate to form spore bearing apothecia. In the prairies it is too dry in most seasons for apothecia to be produced during flowering, thus, in selecting for resistance to *S. sclerotiorum* in sunflower, emphasis needs to be on the root infecting wilt phase.

There have been numerous reports of host resistance within susceptible species, including sunflower. Among

the examples reported, there are no cases of complete immunity. Resistance is one of degree. In our own work on sunflower in controlled environment and field tests, differences in degree of susceptibility were also observed.

Evaluation of sunflower lines would ideally be done under conditions of natural infestation. However, test sites are usually not infested uniformly or perhaps not infested at all. Disease symptoms can readily be incited in field or controlled environment tests by artificial infestation. *Sclerotinia* grows well on a wide variety of substrates. For large quantities of inoculum, it is convenient to grow the pathogen on a cereal such as rye, wheat or oats. The grain steeped in an equivalent amount of water, autoclaved, and inoculated with a small disc from an agar culture produces a mixture of mycelium infested kernels and sclerotia in 10-14 days. This inoculum survives air drying and retains its viability for several months. Inoculum placed near the base of plants 10-30 cm tall and covered with a shallow layer of soil is highly effective for initiating disease, the first symptoms developing in 4-5 days. In the field new infections continue to appear until harvest. Disease development is favored by soil moisture near field capacity.

Figure 2. Infected root with sclerotia. Sclerotia are formed inside and outside infected roots and stems as well as in infected heads.

The sunflower lines evaluated in our tests showed differences in susceptibility by the rate of wilting as well as the percent of plants surviving at maturity. Differences in rate of wilting are illustrated by the results of a controlled environment experiment (Table 1). Two sources of the inbred HA_{61} were compared with the open-pollinated cultivar Krasnodarets and three selections from within the cultivar Krasnodarets. Eight days after inoculation when all Krasnodarets plants were wilted, 45 and 50% of plants in the two HA_{61} lines respectively were free of symptoms. While the final percent survival of the HA_{61} lines was relatively low, the slower rate of wilting was indicative of some resistance to the disease. Comparison of HA_{61} with Krasnodarets artificially infested under field conditions confirmed that HA_{61} was less susceptible than Krasnodarets (Table 2) as measured by the percent plants surviving at maturity. The experiment was repeated in an expanded form, to include three more inbred lines and a hybrid designated CS-466 under conditions of natural and artificial infestation (Table 3). While the rank of the lines was not identical under the two sets of conditions, in general results were similar and the existence of differences in susceptibility was confirmed. The inbred HA_{61} was again more resistant than Krasnodarets. The most susceptible line was CM506. The hybrid CS466 appeared promising and would merit further evaluation.

The reaction of host plants to a pathogen with a low level of speci-

TABLE 1 RESPONSE OF SUNFLOWER TO INOCULATION WITH *SCLEROTINIA SCLEROTIORUM* UNDER CONTROLLED ENVIRONMENT CONDITIONS

Variety	Days after inoculation				
	4	6	8	12	16
	(% plants surviving)				
HA_{61} 1	75	75	50	40	35
HA_{61} 2	75	50	45	35	25
Krasnodarets	35	10	0	0	0
Krasnodarets selection 1	45	40	20	10	10
Krasnodarets selection 2	70	55	15	10	10
Krasnodarets selection 3	80	35	10	5	5

TABLE 2 COMPARISON OF RESPONSE OF HA_{61} AND KRASNODARETS TO INOCULATION WITH *SCLEROTINIA SCLEROTIORUM* IN A FIELD NURSERY

Variety	% plants surviving
Krasnodarets	23.6
Krasnodarets selection	19.9
HA_{61} 1	47.3
HA_{61} 2	36.3

TABLE 3 RESPONSE OF SUNFLOWER LINES TO *SCLEROTINIA SCLEROTIORUM* IN NATURALLY AND ARTIFICIALLY INFESTED NURSERIES

Variety	% plants surviving	
	Natural infestation	Artificial infestation
HA_{61}	80.1	43.3
CS 466	60.8	49.2
CM 502 B	41.1	70.0
CM 400 A	32.2	71.6
Krasnodarets	23.3	28.7
CM 506 B	13.3	10.6

Figure 3 a,b. Early and advanced stages of head rot.

ficity appears to be highly variable and dependent on environmental conditions. In testing lines for comparison it is imperative that a large number of replications be used and plant density and inoculum concentration standardized.

Our tests have covered a relatively narrow spectrum of genetic material, but at the same time have demonstrated existence of a fairly wide range in susceptibility of sunflower lines to *S. sclerotiorum*. A broader evaluation of existing inbred male and female lines could potentially identify parental material with relatively low susceptibility to wilt for development of hybrid combinations. While it is not anticipated that lines with immunity will be identified, it is postulated that exploitation of the differences in susceptibility in existing lines could lead to a significant reduction of wilt in the field.

Dr. Dueck is a plant pathologist at the Saskatoon Research Station, Agriculture Canada

WHOLE CROP FABABEANS FOR SILAGE

S. O. THORLACIUS

On s'intéresse tout particulièrement aux gourganes comme supplément de protéines pour le bétail. En raison de contraintes météorologiques et biologiques et d'un marché restreint, on songe à utiliser les gourganes comme fourrage ensilé.

A cet effet, des recherches ont été entreprises à la station de recherches de Melfort, Saskatchewan, sur les gourganes et aussi sur les pois.

There has been considerable interest in fababeans (*Vicia faba* L.) as a protein supplement for livestock. An annual legume, they are high in protein and fix large amounts of atmospheric nitrogen. Research on rations for swine, poultry, cattle and sheep indicate that fababeans have good potential. However, a market in the commercial feed processing industry does not exist at

present. Also, in many parts of western Canada the growing season is too short to harvest the seed.

An alternative use for fababeans is to harvest the whole crop as silage. Fababeans grow 90-150 cm in height and the yield of whole-crop fababeans has ranged from 7 to 10 tonnes of dry matter per hectare at Melfort.

In 1974, a 3-year research project was begun at the Melfort Research Station on the feeding value of whole-crop fababean and field-pea silage. Field peas (*Pisum sativum* L.) are somewhat similar to fababeans in that they are annual legumes, are high in protein and have the capacity to fix nitrogen. Field peas and fababeans are classed as pulse crops, leguminous plants that produce edible seeds. Since oat is the main annual silage crop in Saskatchewan, the pulse-crop silages were compared with it.

The crops were ensiled at the dough stage; the pods at the bottom of the fababean plants had begun to turn black and most of the pods were full. The peas were firm but still immature.

Silages were evaluated in 6- to 7-week feeding trials with individually fed crossbred lambs, 8-10 months old. Mean initial weight of the lambs was about 35 kg. Results for the final 2 years of the test are in Table 1. During the first year of the test only oat and fababean silages were fed and the results were similar to those during the final 2 years.

TABLE 1. SILAGE DATA

	Fababean	Field pea	Oat
Dry matter (as ensiled), %			
1975	34.2	29.5	34.3
1976	29.5	34.4	34.3
Mean	31.9	32.0	34.3
Crude protein*, %			
1975	19.9	16.9	9.4
1976	19.0	20.4	7.3
Mean	19.5	18.7	8.4
Neutral detergent fiber*, %			
1975	48.7	48.2	53.7
1976	46.6	39.3	52.0
Mean	47.7	43.7	52.9
Acid detergent fiber*, %			
1975	28.6	28.2	32.7
1976	32.2	32.1	40.4
Mean	30.4	30.2	36.6
Digestibility of energy, %			
1975	71.6	74.1	66.7
1976	69.6	72.3	61.4
Mean	70.6	73.2	64.1
Digestible energy*, kcal/g			
1975	3.24	3.50	3.09
1976	3.12	3.38	2.83
Mean	3.18	3.44	2.96
Digestibility of crude protein, %			
1975	72.4	74.2	60.0
1976	71.7	77.3	53.1
Mean	72.1	75.8	56.6
Dry matter intake, g/head/day			
1975	1289	1049	743
1976	1048	958	637
Mean	*1169*	1004	690
Average daily gain, g			
1975	263	198	96
1976	126	98	−13
Mean	195	148	42

*Values are on a dry matter basis.

Crude protein content of the pulse-crop silage was about twice that of oat silage (Table 1), while fiber levels (both neutral and acid detergent) tended to be higher for the oat silage. Digestibility of energy, digestible energy content and digestibility of crude protein were highest for field-pea and lowest for oat silage.

The animals fed fababean or field-pea silage ate much more dry matter than those fed oat silage, and liveweight gains were much higher. Lambs prefer fababean to field-pea silage; those fed it ate more and tended to gain more.

The results indicate that excellent silage can be made from whole crop fababeans and field peas. The digestible energy content would likely be equal to corn silage and substantially higher than most perennial grass or legume silages. Protein content would, of course, be much higher than corn silage and equal to or greater than alfalfa silage or hay.

Further studies are needed before specific rations can be recommended. The high protein and digestible energy content suggest that these silages would be a good source of forage for lactating dairy cows and as a supplement for beef cows fed low-quality hay or cereal straws. They could also be useful in growing rations for beef cattle.

The limited data now available

suggest that yield of whole-crop fababeans is comparable to oats, while yield of field peas will be substantially lower. The greater yield combined with higher capacity for nitrogen fixation indicate that fababeans have greater potential as a silage crop than field peas.

The economics of growing fababeans will depend partly on the extent to which they reduce nitrogen fertilizer requirements in crop rotations. Fababeans yields well only under moist conditions, and would probably be confined to the moister areas of the prairies. These are the areas where requirements for nitrogen fertilizers are highest and where opportunities for reducing summerfallow in the rotation are greatest. As reducing summerfallow increases the need for nitrogen fertilizer, further research may show that fababeans can reduce nitrogen requirements of subsequent cereal or oilseed crops, if grown in rotation and removed as silage.

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NEW DETECTION METHOD FOR INCITANT OF POTATO BACTERIAL RING ROT

S. H. De BOER

La seule méthode de contrôle du corynebacterium sepedonicum, cause du cercle de pourriture bactérienne dans la pomme de terre, consiste à n'utiliser que des graines saines. Or, il n'existait pas jusqu'à maintenant de techniques de diagnostic précises et fiables. On tente, à l'heure actuelle, d'identifier cette bactérie selon une méthode pratiquée en pathologie animale. Il s'agit d'un processus visant à colorer les anticorps au moyen de rayons fluorescents indirects.

Bacterial ring rot of potatoes is caused by the bacterium, *Corynebacterium sepedonicum*. The disease was first reported in Canada in 1931 in the province of Quebec and since then has been found in all Canadian provinces. Up to 75% crop loss has been experienced in the past but strict certification regulations are now keeping the disease in check so that actual yield loss is low today. Economic loss to growers still occurs, however, for even one diseased plant in a field will prevent certification with a concomitant loss in profit. Moreover, the potential hazard of a major bacterial ring rot outbreak still exists.

Corynebacterium sepedonicum infects the potato plant from the seed piece via the vascular tissue. It causes blockage and necrosis of the vascular system which results in the foliar symptoms of wilting, yellowing, necrosis, and sometimes death of the plant. The bacteria also move through the stolons into the new tubers where symptoms are a characteristic creamy yellow, cheesy, odorless rot in the vascular ring. The causal organism is highly infectious and is easily spread from an infected tuber to healthy tubers by cutting knives and other equipment. Thus even a very low level of infection in potato seed constitutes a potential hazard.

The only known method of control is the use of clean seed. Hence there is a zero tolerance for bacterial ring rot in all classes of seed potatoes in Canada. For certification to be totally effective and just, however, diagnosis of the disease must be accurate and reliable. Unfortunately, such a diagnostic technique has not been available.

Even when active ring rot infections are present the symptoms may

be obscured by secondary microorganisms which readily proliferate in the diseased tissues. The causal organism is difficult to isolate as it grows very slowly and is rapidly overgrown by other microorganisms; no selective medium has yet been developed. The Gram stain method is widely used to confirm the presence of *C. sepedonicum,* but this stain is not specific for the pathogen and a great many other saprophytic bacteria which may be present in the potato tissue or soil also give a positive test.

In recent years various serological techniques have been adapted especially in the medical field for specifically detecting the presence of a particular microorganism. Many of these techniques are also applicable to plant pathology. One technique that is proving useful for detecting *C. sepedonicum* is the indirect fluorescent antibody staining method. In this procedure specific antibodies are produced against *C. sepedonicum* by injecting a pure culture of the organism into a rabbit and collecting the antiserum which contain the antibodies. The antibody fraction of antiserum from a second rabbit is injected into another animal such as a goat or sheep to produce antibodies against rabbit antibodies. These anti-rabbit antibodies are then conjugated to a dye called fluorescein isothiocyanate (FITC) which fluoresces green when activated with specific wavelengths of light. In the detection procedure a smear is made from the diseased tissue on a glass microscope slide. This preparation is first stained with the specific antiserum allowing the antibodies to adhere to *C. sepedonicum* cells. The excess specific antiserum is washed off and the preparation is stained with the anti-rabbit antiserum conjugated with FITC. These conjugated antibodies in turn adhere to the specific antibodies on the *C. sepedonicum* cell wall surface and again the excess is washed off (Figure 1). The preparation is viewed through a microscope with darkfield or incident illumination and appropriate filter combinations for controlling the wavelengths of light. The FITC dye which coats any *C. sepedonicum* cells that may be present is seen to fluoresce. *Corynebacterium sepedonium* cells appear as bright greenish cells against a dark background (Figure 2). Other bacteria that may be present have different

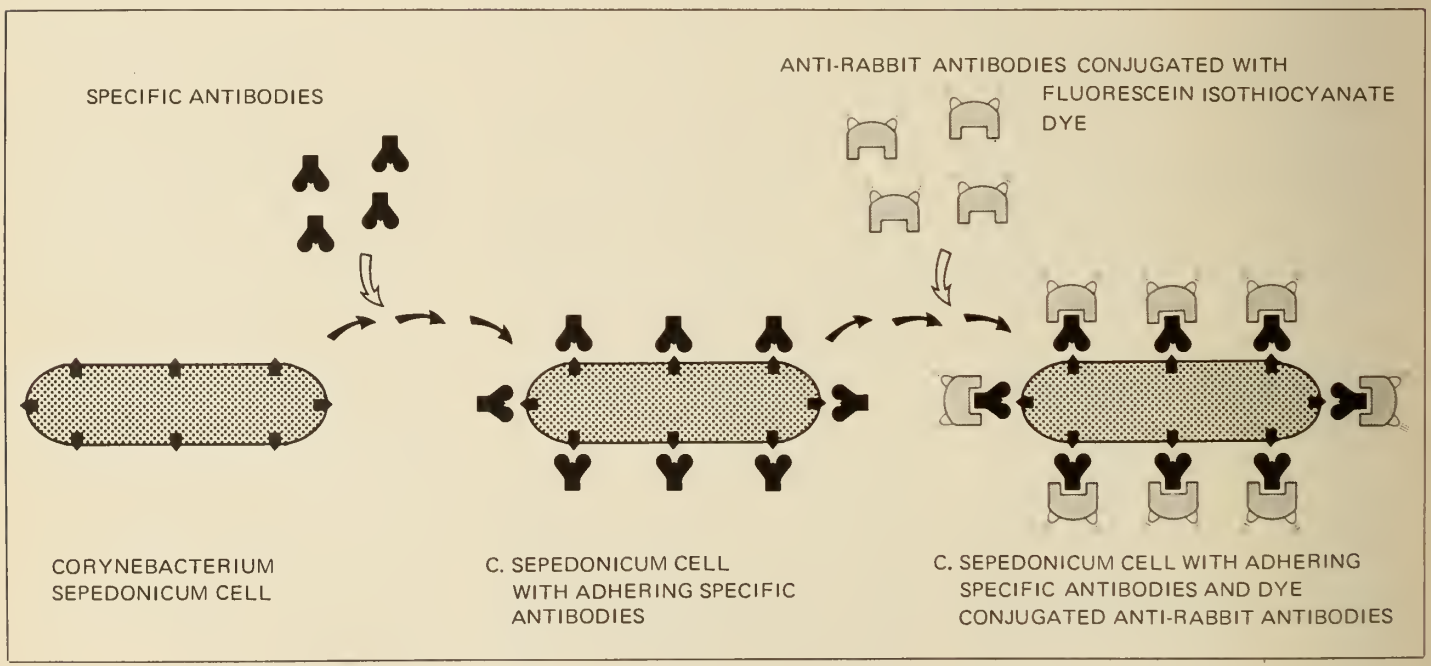

Figure 1. Schematic representation of indirect fluorescent antibody staining of a *Corynebacterium sepedonicum* cell.

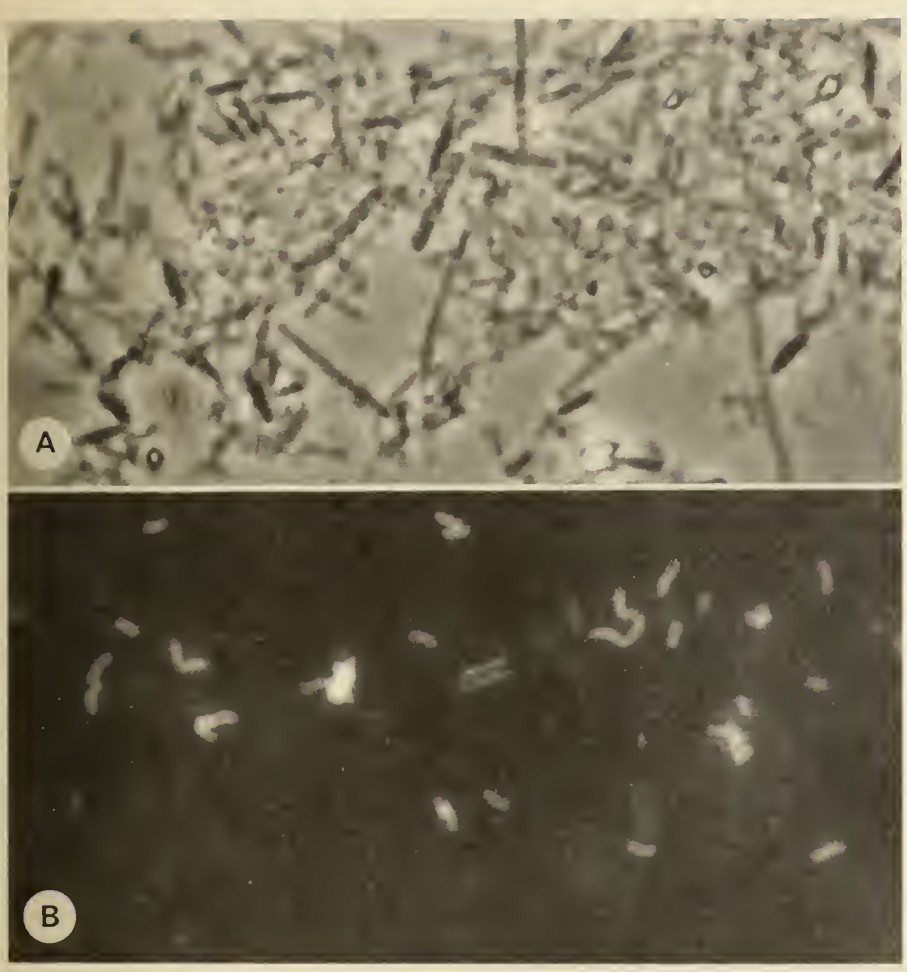

Figure 2 (A). Smear of decayed potato tissue viewed with phase contrast microscopy revealing many different types of bacteria and (B) same microscope field viewed with incident illumination and controlled wavelengths of light showing specifically stained, fluorescing *Corynebacterium sepedonicum* cells.

cell wall characteristics and therefore fail to absorb the specific antibodies and, of course, no conjugated antibodies can adhere and the cells do not fluoresce. Very occasionally other bacteria to adsorb some antibodies and show fluorescence but these reactions usually can be recognized by their weak level of fluorescence and a cell morphology different from that characteristic of *C. sepedonicum*.

The indirect fluorescent antibody method requires sophisticated microscope equipment as well as a source of specific antiserum. If these are available the technique is simple enough to be practical in any diagnostic laboratory. It is anticipated that the use of this sensitive and specific technique for confirming the diagnosis of bacterial ring rot of potato in conjunction with certification programs will lead to a further decrease in the incidence of the disease.

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WILD OATS EFFECT ON QUALITY AND QUANTITY OF FLAX AND RAPESEED

P. N. P. CHOW and
D. G. DORRELL

La présence de mauvaises herbes non seulement réduit-elle la quantité des récoltes mais aussi la qualité. Des expériences à cet effet ont été menées sur le lin et les graines de colza. On a ainsi déterminé que par l'application d'herbicide, on a amélioré la qualité de l'huile extraite et le volume des récoltes.

The public may be aware that weeds reduce crop yields, but generally do not know that weeds can also reduce the quality of seeds. A series of experiments with flax and rapeseed was conducted at the Brandon Research Station, followed by seed-quality analyses at the Morden Research Station.

Field experiments indicated that diclofop-methyl (Hoe Grass) at rates of 0.84 to 1.68 kg/ha provided good control of wild oats and increased the oil content and iodine number of flax seeds when compared with the weedy check (Table 1). This improvement in iodine number was caused by a significant increase in linolenic acid and a corresponding decrease in oleic acid content of the oil. While there was a slight increase in protein content, it was not significant. A similar increase in oil content, but not protein content, was noted in rapeseed (Table 2).

Hoe 29152 (trifop-methyl), an analogue of diclofop-methyl, at rates of 0.2 to 0.4 kg/ha also gave excellent control of wild oats and increased flax yields over the weedy check. As noted with diclofop-methyl, oil quality but not protein content was improved. In this test however, the hand-weeded treatment also showed an improvement in oil quality, indicating that the response was not due solely to the herbicides.

Flax was then grown in the greenhouse under weed-free conditions to confirm this observation. Rates of diclofop-methyl as high as 1.12 kg/ha did not affect seed quality or oil composition (Table 3). However, the highest rate of 1.68 kg/ha decreased protein content and increased oil content, but had no effect on iodine number. Thus, under field conditions, it would appear that the changes in seed and oil quality were due to reduced competition from wild oats resulting from the application of herbicides. Under weedy conditions, competition from the wild oats for water, soil nutrients and sunshine depleted the resources available for normal growth and maturation of the crop. This stress

TABLE 1. EFFECT OF DICLOFOP-METHYL ON SEED QUALITY AND YIELD OF NORALTA FLAX (FIELD EXPERIMENT, 1975)

Treatmetnt	Protein (%)	Oil (%)	Iodine[2] No.	Seed Yield Flax	Seed Yield W. Oats (g/m²)
Check, weedy	41.7 a[1]	38.4 b	177 b	34 b	9 5
0.84 kg/ha	41.9 a	39.0 a	182 a	127 a	0.7 b
1.12 kg/ha	42.3 a	39.1 a	182 a	128 a	0.2 b
1.68 kg/ha	41.8 a	39.2 a	183 a	124 a	0.1 b

[1]Means within columns followed by the same, letter are not significantly different at the 5% level (Duncan's multiple range test).
[2]Higher numbers are desirable.

TABLE 2. EFFECT OF DICLOFOP-METHYL ON SEED QUALITY AND YIELD OF TOWER RAPESEED (FIELD EXPERIMENT, 1975)

Treatment	Protein (%)	Oil (%)	Seed Yield Rapeseed (g/m²)	Seed Yield W. Oats (g/m²)
Check, weedy	41.6 a	35.5 c	20 b	57 a
0.56 kg/ha	41.4 a	37.2 b	95 a	4 b
0.84 kg/ha	40.8 a	37.9 ab	105 a	4 b

TABLE 3. EFFECT OF DICLOFOP-METHYL ON SEED AND OIL QUALITY OF NORALTA FLAX (GREENHOUSE EXPERIMENT, 1978)

Treatment	Protein (%)	Oil (%)	Iodine No.
Check, weed-free	40.9 a	39.2 c	175 a
0.84 kg/ha	40.7 a	39.2 c	176 a
1.12 kg/ha	41 4 a	39.3 b	176 a
1.68 kg/ha	39.2 b	39.5 a	176 a

apparently impaired rate or duration of oil and fatty acid synthesis.

These studies demonstrated that wild oats adversely affected the oil content and quality of flax and rapeseed, but not the protein content. When wild oats were controlled with diclofop-methyl and Hoe 29152, the quantity and quality of oil in seeds were maintained at normal levels.

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TECHNIQUE POUR L'ÉCHANTILLONNAGE DES CULTURES DANS LE SOL GELÉ

Dr R. BOLDUC

The sampling of soil or plants during the winter or in permafrost areas may be required for various scientific, technological or industrial purposes. Such sampling presents special problems because of soil hardness and the presence of stones encrusted in the frozen earth makes penetration difficult. A portable tubular drill has been developed with which this work can be quickly carried out by only two men.

L'échantillonnage de sol et de plantes pendant la saison hivernale et dans les régions de permafrost peut être requis pour diverses raisons d'ordre scientifique, technologique ou industriel. Le prélèvement de tels échantillons gelés présente des problèmes spéciaux associés avec la dureté du sol et les cailloux incrustés dans la terre gelée qui s'opposent à la pénétration des instruments. Nous avons mis au point une foreuse tubulaire portative avec laquelle on peut opérer ce travail avec rapidité en exigeant la collaboration de seulement deux hommes.

La mèche (figure 1) utilisée consiste en un tube d'acier mécanique étiré à froid et sans soudure à l'intérieur. La paroi de 5 mm d'épaisseur est lisse à l'intérieur et usinée avec des rainures spiralées de 1 mm de profondeur à l'extérieur avec un pas de vis de 1 cm. Les diamètres externes des cylindres utilisés ont de 12 à 20 cm. Des dents au carbure de 7 mm de largeur sont soudées avec un espacement de 2,5 cm sur la bordure du cylindre destinée à scier dans le sol.

Pour les sols sableux et rocailleux, les dents sont alignées exactement les unes derrière les autres, avec une pente de 15° vers l'avant de la coupe dans le sens de rotation du cylindre. Pour les sols argileux, les dents chevauchent de part et d'autre du trait de coupe.

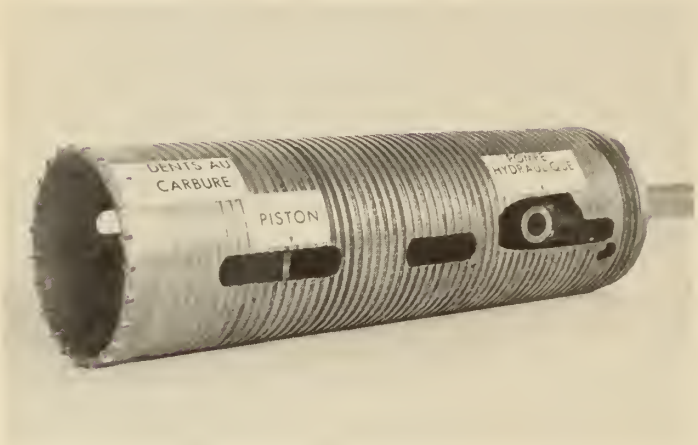

Fig. 1. Mèche tubulaire munie de dents au carbure. Un piston hydraulique est installé à l'intérieur pour dégager la carotte de sol.

Fig 2 Tarière portative de fabrication commerciale utilisée pour faire tourner la mèche à une révolution de 150-300 rpm.

La longueur du tube peut avoir de 0,5 à 1 m et une tige de 4 cm de diamètre et 0,6 m de longueur est vissée dans le couvercle soudé à l'autre extrémité du tube pour raccorder la mèche au moteur qui l'actionne.

Un piston en acier est installé à l'intérieur de la mèche afin d'expulser la carotte de sol après l'extraction (figure 1). Celui-ci est mu par un vérin hydraulique de 28 cm ou plus de longueur avec une portée d'action de 19 cm ou plus et pouvant fonctionner dans la position horizontale. La base du vérin est fixée sur la paroi interne du couvercle et orientée de telle sorte qu'il puisse être actionné à travers les ouvertures pratiquées dans la paroi du cylindre. Une plaque circulaire en métal est installée à l'extrémité de la tige du vérin pour repousser la carotte de sol vers l'extérieur. Une tarière portative (fig. 2) à deux hommes, mue par un moteur à essence à deux temps de 7 c.v. à plein régime, est utilisée pour faire tourner la foreuse à une vitesse minimale de 150 rpm. Une révolution plus lente exige trop d'effort de la part des opérateurs, et une révolution plus rapide que 300 rpm exige trop de puissance de la part de l'engin utilisé (tableau 1).

Une telle puissance nous a permis d'effectuer tous les travaux à une vitesse de 150 rpm. Dans ces conditions, la mèche coupe à travers les zones les plus délicates du sol sans modifier leurs principales caractéristiques physiques, telles que la température, la texture, la structure et la teneur en eau. Par conséquent, il ne faut pas ajouter d'eau, d'huile ou tout autre matériel étranger pendant l'opération. Une telle carotte préserve l'intégrité complète des racines les plus fragiles (figure 3). Un diamètre de 15 cm permet à la foreuse de s'enfoncer à des profondeurs de 20 à 40 cm dans les mêmes conditions de travail.

La foreuse ne peut pas creuser à travers plus de 15 cm de neige ou de glace. Autrement la chaleur de friction du cylindre sur la carotte de neige dégage une pellicule d'eau qui glace instantanément sur le métal froid et bloque ainsi la carotte à l'intérieur du cylindre. Il faut donc enlever la neige et dégager le point d'échantillonnage jusqu'au sol avant de forer.

Aussitôt que la carotte est extraite du sol, on la dépose dans un sac de plastique à l'intérieur d'une boîte isolée pour la protéger contre les températures trop basses ou trop élevées de l'air ambiant (figure 4). Tous les équipements sont transpor-

TABLEAU 1 RELATIONS ENTRE LE POIDS À APPLIQUER SUR LA FOREUSE, LA VITESSE (RPM) DE LA MÈCHE (12 cm DE DIAMÈTRE) ET LE TEMPS REQUIS POUR EXTRAIRE UNE CAROTTE DE 20 cm DE LONGUEUR DANS UN LOAM ARGILEUX GELÉ À −28°C ET SATURÉ D'EAU AVANT LE GEL

rpm	Poids (kg)	Temps (min)
50	136	3′–5′
150	59	1′–1 5′
300	32	0 5′–0 8′

Fig. 3. Racines de luzerne exposées à nu après avoir délavé une demi-section de la carotte de sol. On remarque les nodules et le système radiculaire intacts.

tés à l'aide de deux traineaux de fabrication commerciale. A l'occasion, les opérateurs se déplacent en raquettes, modèles pattes d'ours, pour ne pas enfoncer dans la neige et pouvoir travailler plus à l'aise.

Cette technique de prélèvement permet de collecter des échantillons uniformes de sol contenant un nombre représentatif de plants, par exemple, une moyenne d'environ six plants de luzerne par carotte. Le volume constant de sol récupéré permet de mesurer les rendements de croissance par unité de superficie cultivée en tant que mesures qualitatives et quantitatives. Les pierres qu'on retrouve en grand nombre dans les sols sableux entre autres ne sont pas un obstacle sous aucune condition de prélèvement. La mèche pèse 13 kg et sa facilité de manœuvre autonome en fait un outil pratique très efficace et facile à faire fonctionner, même à des températures inférieures à −20°C.

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FROM FOREST TO FARM

J. R. HUNT and
G. M. BARTON

Suite à la visite des scientistes forestiers canadiens en URSS, on a entrepris une étude sur l'utilisation du feuillage des arbres comme aliment pour animaux. Les premiers résultats ont démontré que les espèces de conifères choisis au Canada sont sensiblement pareilles à celles utilisées en URSS, et qu'elles se prêteraient bien à la fabrication d'aliments pour ruminants. Cependant, on a mené d'abord des expériences sur des poulets à rôtir afin de déterminer si le produit à base de feuillage était toxique. Il s'est avéré sans danger, mais n'a pas produit sur la croissance des animaux les résultats démontrés en URSS.

Interest in the use of tree foliage as a poultry and animal feedstuff developed after Canadian forestry scientists visited the Soviet Union. The scientists learned that the U.S.S.R. was committed to the widespread use of foliage as a feedstuff (muka)[1] to the extent of 100,000 tonnes annually.

Furthermore, Soviet reports have indicated that this feedstuff stimulates the growth of ruminants and monogastrics or has led to increased production efficiency of commodities such as eggs or milk when fed up to a 10% supplement level.

[1]Muka, the Russian word for flour, is defined as finely ground, dry foliage which is to be used as a fodder vitamin supplement. Although muka can be made from pure needles (coniferous species) or pure leaves (deciduous species), it has generally been made in the U.S.S.R. from "technical or commercial foliage", i.e., all needles, leaves, twigs, shoots, and branches up to 0.6 cm in diameter.

To examine these impressive claims, in terms of Canadian tree species and with respect to North American control diets, Agriculture Canada's Research Branch and the Western Forest Products Laboratory (now Forintek) agreed to run joint studies. Although some work is still underway, enough data are available to form an overall viewpoint on the future of foliage as a feedstuff in Canada.

Lodgepole pine and white spruce, growing in the interior of British Columbia, were chosen initially because they, or closely related species, are well represented in Canada and the United States and because wholetree logging is more likely to start with these species. A comparison of analytical data for essential oils, carotene, chlorophyll, protein, and mineral constituents indicated only small variations from data obtained from Soviet species. Site and seasonal variations had little effect on these constituents and losses of carotene, chlorophyll, and protein were minimal for felled trees up to one month under summer conditions. Thus normal tree harvesting procedures can be practised. And unlike forage crops, coniferous foliage can be harvested in winter. The work to date has shown that muka made from spruce or pine needles has a composition that provides about 6% protein and 40% acid detergent fiber. This analysis suggests a ruminant type feed, but material was fed to broiler chicks to determine if the product is toxic.

When spruce muka was fed to broiler chicks from hatching to four weeks of age, it was found that it depressed growth more than the same addition of cellulose to the diet. One problem was that the birds seemed to be avoiding the needle

product. The diets were therefore pelleted, resulting in an improved growth rate. When the diet contained 10% muka, growth was about 89% that of the control diet. This growth was made on comparable amounts of feed intake. One of the interesting aspects of the work is that mortality was not affected by the addition of the muka to the poultry rations. Nor was mortality affected in other experiments with pine in which diets contained as much as 30% muka. To assess toxicity, birds were sacrified after the test and the internal organs to body weight ratios of birds on the various diets were compared. Feeding muka did not alter the ratios of the organs studied.

One of the product's problems may be its unpalatability. Pine needle odor is strong and this could depress the bird's feed consumption. Removal of this odor-causing material from the product by extraction before feeding might overcome the problem. There has been some success using steam distillation. Whole needles were steam distilled, but the interior of the needle did not release all of the volatiles.

Work is underway to investigate muka's value to ruminants. Sheep are being used as test animals.

Other studies are investigating the use of extraction to remove organic compounds. These preliminary extraction studies have indicated that about 25% of the muka is extractible with a benzene-ethanol solvent mixture.

Not unexpectedly, Canadian and U.S. poultry and animal studies involving foliage as feedstuffs have not shown the improved growth responses demonstrated by the Soviet studies. This is believed to be due to energy rich North American control diets which have been formulated for maximum growth. While other tree species must be examined for toxicity, and the effect of solvent extraction of muka on growth response remains to be evaluated, there is still some optimism for the possible use of foliage for feed in Canada.

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LIGHT TRAPPING CORN EARWORM AND FALL ARMYWORM

H. B. SPECHT

Grâce aux pièges lumineux, on a réussi à recueillir des données quant aux activités des vers de l'épi du maïs et des légionnaires uniponctuées qui s'attaquent au maïs. Les informations ont été transmises aux cultivateurs qui ont pu prendre les mesures nécessaires au moment opportun, réduisant ainsi les quantités d'insecticides utilisés.

Light traps of various forms have been used to collect and study moths since man has used fire. With the invention of the incandescent light bulb, refinements in light trapping techniques allowed entomologists to predict insect activity. Today with fluorescent and mercury lights emitting light near ultraviolet wave lengths, traps are being used for predicting localized outbreaks and for timing the application of insecticide controls of some important pests in integrated pest management programs. These programs have resulted in improved pest control with fewer applications of chemicals and in some cases with reductions in rates of application where the populations do not warrant maximum control.

During the summer and autumn of 1978 a network of 3 mercury vapor and seven Elisco 15-watt light traps (figure 1) were maintained along the west and south coasts, a central corn growing area inland, and a corn growing area along the north coast of Nova Scotia (figure 2). The traps were emptied each morning, the moths were spread evenly between layers of quilting cotton in a mailing carton and forwarded weekly to the Kentville Research Station where they were identified.

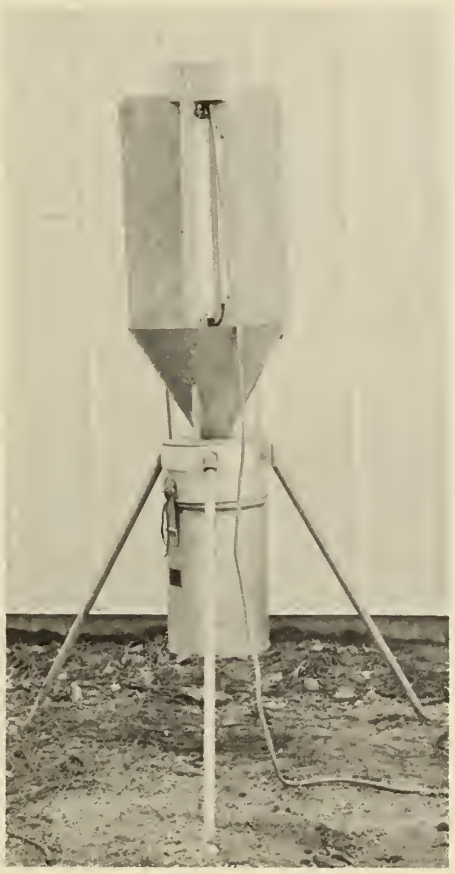

Figure 1. The Elisco 15-watt G.E. Blacklight trap used in all locations except #6, 7 and 8. Moths drop into the funnel after colliding with the fin-like panels radiating from the light bulb. A Vapona strip containing dichlorvos in the canister below the funnel prevents moth injury.

Corn earworm adults first appeared in a trap during early August along the south coast, on Second Peninsula, Table 1. Early maturing sweet corn was severely infested with corn earworms in this area during the latter half of August. Small numbers of moths were obtained from Brier Island, The Hawk and Kentville areas in the latter half of August, and the latter area exhibited a light and scattered infestation of worms in sweet corn in September, followed by a dearth until the last week of the month when a high catch was taken at The Hawk and minor catches at most other traps resulting in a later infestation on very late maturing sweet corn.

TABLE 1. CORN EARWORM, *HELIOTHIS ZEA* (BADDIE), ADULTS CAPTURED IN LIGHT TRAPS, 1978

	Trap Number									
	1	2	3	4	5	6	7	8	9	10
Aug.										
3-10				16						
11-18	1	1	1	15						
20-30	3			11		1	1			
Sept.										
1-2			10	2	1					
22-30	3	2	28	2			2	2		1
Oct.										
1-3	2		1				1	1		1
6-10			6				1	1	1	3
30				1						
Total	9	3	46	47	1	1	5	4	1	5

TABLE 2. FALL ARMYWORM, *LAPHYGMA FRUGIPERDA* (J.E. SMITH) CAPTURED IN LIGHT TRAPS, 1978.

	Trap Number									
	1	2	3	4	5	6	7	8	9	10
Aug.										
1-4				5						
10-14				12						
18-20				7						
27-28				5						
Aug. 31-										
Sept. 4		2	7	27	4	2	4			
Sept 5-12				25	1	3		2	1	
15-29	2	2	1	4	3		2	1	13	2
Oct. 2-3	2			4		5		3	2	1
6-10				4	1	1	2	1		
14-16	2			2		1		3		
Total	6	4	8	95	9	12	8	10	16	3

Figure 2. Map showing the location of the light traps in Nova Scotia 1978.
1. Brier Island; 2. Kemptville; 3. The Hawk; 4. Second Peninsula; 5. Kentville; 6. Steam Mill; 7. Upper Dyke; 8. Woodside; 9. Bible Hill; 10. Durham.

Fall armyworm adults first appeared about the same time, in similar numbers and in the same area as the corn earworm, Table 2. A large catch was taken in the Second Peninsula trap during early September, resulting in a large infestation of fall armyworms in field corn in this area. A small catch in Kemptville, Kentville, Steam Mill and Upper Dyke predicted the variable infestation of worms that occurred in these areas. In the latter half of September small numbers of fall armyworm adults were taken in all traps except Steam Mill, which was without captures. Light variable catches continued in mid October in the traps at Brier Island, Second Peninsula, Kentville, Steam Mill, Upper Dyke and Woodside.

During the 1978 season most of the corn earworm moths were captured in traps located at Second Peninsula and The Hawk, and the majority of the fall armyworm adults were retrieved from the Second Peninsula trap. Although adults of both species began to appear at the same time, corn earworm were more numerous during early and late season, and fall armyworm were more numerous during mid season. Adults of the fall armyworm were more widely distributed.

The information thus obtained was disseminated to the growers through the provincial extension services alerting them to the quantities and areas of activity during the sweet corn growing season. The early season maturing corn was nearly insect free with one or two spray applications. Some of the mid and late season fields were severely damaged.

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WINTER — SPRING BARLEY HYBRIDS

S. O. FEJER and
G. FEDAK

La culture de l'orge se révèle être l'une des plus importantes cultures fourragères au Canada. Afin d'améliorer les espèces cultivées au pays, on a tenté de croiser de l'orge printanier et de l'orge hivernal. Seules certaines espèces se sont bien combinées mais il en est ainsi dans tous les tests de croisement. Cependant, règle générale, les résultats obtenus se sont avérés positifs (tableau 1).

Canada's 12-15 million acre barley crop is one of the country's most important feed crops. It is not indigenous to Canada but was introduced primarily from Europe and Asia. The most significant introduction was Mensury (Mensheuri), a heterogenous bulk from Manchuria, which was reselected to give some excellent early cultivars such as Mensury Ottawa 60, OAC-21, etc. The latter served as a standard for malting quality for many years. During its introduction in the mid-1920s, the harvesting was done manually, causing handlers to object to the irritating rough-awned characteristics. To improve the situation, a type of barley named Lion was introduced from Eastern Europe and its smooth-awned characteristics incorporated into existing cultivars. These two introductions were used so much in Canada breeding programs that the pedigrees of virtually all the contemporary barley cultivars can be traced back to these two original sources.

The barley breeding programs in Canada have produced several excellent cultivars and even better ones are on the horizon; however, many programs employ only a small portion of the germ plasm available in barley. For example, there is little information available on the potential of improving spring barley by intercrossing with winter types. The winter barley program at the Ottawa station is being phased out for lack of sufficient winterhardiness for the surrounding area, but the remaining unique germ plasm, some with other *Hordeum* species (wild barleys) in its ancestry, was crossed to several spring cultivars and the progeny evaluated, mainly for yield. The heterosis in F_1 as measured on spaced planted progeny was unexpectedly high, as shown by the robust growth of the hybrid plants compared with one spring cultivar,, Trent (Figure 1). Heterosis expression in solid seeded progeny was somewhat less (Table 1). The heterosis in the F_1 was of academic interest but not very useful to a barley producer, so the material was advanced to homozygosity and the progeny evaluated at that stage. During the advance to homozygosity the winter segregates were rogued out and some selection was practised for other agronomic traits such as resistance to lodging and diseases.

Figure 1. Spring barley cultivar Trent, flanked by double rows of winter-spring F_1 hybrid progeny rows, under spaced planting, with vegetative winter barley in the foreground.

The yield traits of F_7 homozygous progeny showed that not all progeny from all combinations were superior to the spring parent, but there were some excellent lines derived from a combination involving Champlain and OB 66-23 as the spring parent (Table 1). Some of the top F_7 lines

TABLE 1. YIELDS (KG/HA) AND LEVELS OF YIELD ADVANTAGE IN F_1 AND F_2 PROGENY OF SOME WINTER-SPRING BARLEY CROSSES

Origin	Spaced planted F_1	%*	Solid seeded F_1	%	Solid seeded F_2	%
Champlain	3207	—	4995	—	2950	—
Champlain x winter #29	8044	150.3	5805	16.2	3760	27.4
Champlain x winter #45	7371	129.3	6216	24.4	2730	−7.5
Champlain x winter #60	4341	35.4	3996	−20.0	3420	15.9
Champlain x winter #65	6867	113.8	4539	−9.1	2790	−5.4
Champlain x winter #100	5457	70.2	3285	−34.2	4020	36.3
Average	6414	100.00	4768	−4.5	3340	13.2
OB 66-23	4022	—	3885	—	3150	—
OB 66-23 x #29	6184	53.7	4562	17.4	3590	14.0
OB 66-23 x #45	7779	93.4	3518	−9.4	2620	−16.8
OB 66-23 x #60	4926	22.5	4195	8.0	3160	0.3
OB 66-23 x #65	7283	81.1	4395	13.1	3790	20.3
OB 66-23 x #100	7300	81.3	5372	38.3	3580	13.7
Average	6694	81.5	4408	13.5	3350	6.3

*% yield advantage over spring parent.

yielded well over 5000 kg/ha when the best parent, OB 128-1, yielded 4010, and the leading cultivar, Vanier, only yielded 3680 kg/ha. These trials have shown that there is considerable potential for improving spring barley by using the technique of winter x spring hybridization. Only certain combinations combine well but this is to be expected with any breeding material. The material derived can be used for subsequent hybridization, and in this way increase the size and diversity of the barley breeding gene pool.

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ECHOES FROM THE FIELD AND LAB

ECHOS DES LABOS ET D'AILLEURS

PUREBRED LIVESTOCK EXPORTS Canada's exports of purebred livestock and semen last year hit a record of $41 million, and 1979 should be even better

Agriculture Canada officials in Ottawa say that four factors contributed to the bright export picture — high national animal health standards and freedom from serious diseases, the lower value of the Canadian dollar, national livestock performance measurement programs and aggressive marketing by the industry

Purebred dairy cattle accounted for most of the 1979 exports — 17,828 animals worth $24.4 million More than 90% of these sales were of Holstein-Friesians South American countries had growing demand for Canadian dairy purebred cattle, particularly Brazil with imports of 1,303 head China is also a potential new market

Beef cattle exports totalled 8,615 head in 1978 for a gross value of $10.8 million. For purebred swine, 2,160 animals were exported, mainly to Mexico, and were valued at $850,000. The balance of exports is sales of bull semen and cattle embryos.

DAIRY PROTEIN TESTING TRIAL A six-month project has been launched in Ottawa to see how Agriculture Canada's Record of Performance (R.O.P.) program for dairy herds could be expanded to include milk protein measurement.

There now are about 4,600 Canadian dairy herds (215,000 cows) enrolled in the R.O.P. program, which provides participating dairy farmers with a government-supervised account of how their cows are performing. The information is useful in guiding farmers' breeding and management decisions.

Under the program, a team of 250 inspectors, divided into 22 zones, supervises milking on each farm 10 times a year. The supervisors identify each cow, measure the amount of milk produced at evening and morning milkings, and perform a butterfat test on the site. The information is processed in Ottawa and returned to the farmer in a computer print-out.

In the new project, Agriculture Canada's livestock division is working with Foss Electric Canada Ltd., of Cornwall, Ont. using the company's line of Danish milk testing equipment to perform butterfat tests as well as the new protein test for 90 R.O.P. herds in the Cornwall area.

Milk protein is becoming increasingly important to the dairy industry. Protein levels have declined because farmers focus on breeding cattle for milk output and butterfat content. But consumers are increasingly interested in the non-fat content, and processors know that more protein means a higher yield of cheese and other by-products.

NEW BIRDSFOOT TREFOIL VARIETY A new, winter-hardy variety of birdsfoot trefoil has been licensed by Agriculture Canada.

The new variety, Cree, was developed at the Saskatoon, Sask. Research Station of Agriculture Canada, and is the first trefoil variety bred in western Canada.

The breeding project started in 1950 and involved several generations of selection for increased winter hardiness and superior traits, such as high forage and seed yields, and seedling vigor.

From 1960 to 1975 extensive performance testing was carried out throughout the Prairie Provinces and British Columbia. These tests showed Cree to be more winter hardy and about 15% higher in forage and seed yield than the standard variety, Empire.

Compared to the eastern variety, Leo, Cree is equal in hardiness and forage yield, but higher in seed yield, and has excellent seedling vigor.

Birdsfoot trefoil resembles alfalfa in appearance, but is flatter in growth habit. At seed maturity, the pods extend at right angles to the flowering stem and give the appearance of a bird's foot.

Birdsfoot trefoil is a legume that is adapted to low-lying poorly-drained soils. It does not cause bloat in cattle.

"REPELLANT" PLANTS FOR HOME GARDENS Dr. Ronald Howard, of the Alberta Horticultural Research Center at Brooks says that increased interest in organic gardening has aroused the curiosity of many home gardeners concerning the use of plants which can repel harmful insects that feed on garden vegetables.

Garlic, marigolds and mints are some examples of "repellant" plants which are well known for their offensive characteristics. These offensive characteristics can be used to good advantage in a home garden providing the repellant plants are available from local seed or garden stores and a person is willing to take the time to plan and plant his garden in the proper fashion. The added space occupied by the repellant plants may necessitate the use of a larger garden area.

The following list of some common garden crop pests and the names of plants that will repel them was set out by Dr. Howard.

Pests	Repellant Plants
Ants (and the aphids they carry)	Spearmint, tansy *(Tanacetum vulgare)* plus
Aphids	garlic, chives, other alliums, coriander, anise, nasturtium and petunia around fruit trees
Asparagus	Tomato
Cabbage	Adjacent row of mint, tomatoes, rosemary or sage
Cabbage moths	Mint, hyssop, rosemary, thyme, sage, wormwood, celery, catnip, nasturtium
Carrot flies	Rosemary, sage, wormwood, black salsify, various alliums, coriander
Chinch bugs	Soybeans
Colorado potato beetles	Green beans, horseradish, flax
Cucumber beetles (spotted and striped)	Tansy, radish
Cutworms	Tansy
Flea beetles	Wormwood, mint, catnip. Interplant cole crops (cabbage, cauliflower, broccoli and brussel sprouts) with tomatoes
Gophers	Castor bean
Leafhoppers	Petunia, geranium
Mice	Mint
Mites	Onion, garlic, chives
Nematodes	Marigold (African and French varieties), salvis (scarlet sage), dahlia, calendula (pot marigold), asparagus
Rabbits	Allium family
Rose chafers	Geranium, petunia, onion
Slugs	Prostrate rosemary, wormwood
Squash bugs	Tansy, nasturtium
Tomato hornworms	Borage, marigold, opal basil
White flies	Nasturtium, marigold, nicadra (perivian ground cherry)
Wireworms	White mustard, buckwheat

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